

A Perspective on Space Exploration Technology Catalysis—A Rationale for Initiating 21st Century Expansion of Human Civilization into Outer Space

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A PERSPECTIVE ON SPACE EXPLORATION TECHNOLOGY CATALYSIS--A RATIONALE FOR
INITIATING 21st CENTURY EXPANSION OF HUMAN CIVILIZATION INTO OUTER SPACE

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SUMMARY

This paper attempts to provide a rationale for the human exploration of outer space. Observations of the techno-catalytic potential are presented. Transferability to the terrestrial environment of 21st century Earth is discussed. The many threats to future survival of this planet's sensitive ecosystem are also discussed in relation to the techno-ecological harmony that might be achievable due to the extreme demands that are naturally imposed on the development of (civilian/human) space technology. The human attempt to inhabit the inner solar system (the Moon, Mars, etc.) is proposed as the ultimate and most appropriate technology driver for the myriad of socio-economic, ecological, and technological needs that will accompany 21st century Earth societies.

INTRODUCTION

The concept of a technology catalyst is defined as a source of challenges, which, if pursued, can significantly accelerate the process of technological innovation. The theme, technology catalyst, inherently suggests a relationship between the rapid evolution of new technology and uniform societal progress, growth, and expansion in all related sectors.

Some of the most basic and ubiquitous technology catalysts to have collectively propelled the growth and development of Western societies (in particular the United States and some European countries) are: (1) mercantilism/commercialism--trade and commerce, domestic and international competition; (2) intercultural interaction/dynamics; (3) territorial expansionism--military conquest; (4) national security--war, and the threat of war; (5) changing demands for energy and resources--materials, and human intellectual and physical might; (6) natural disasters--cyclical planetary crustal and atmospheric anomalies (hurricanes, earthquakes, etc.), epidemics and disease; (7) basic economic necessity; (8) physical and scientific/mathematical exploration of the unknown. From the present standpoint of the United States and most of the industrialized world, each of these catalysts have in different ways (ref. 1):

(1) Contributed significantly to the technology base of the United States and the world.

(2) Demonstrated the application of technology toward peaceful ends.

(3) "Pulled through" advances in science and technology of critical importance to the United States' future economic strength, and to overall global, international economic interdependency.

(4) Provided a highly visible showcase for technological innovation and application.

(5) Provided a source of motivation and drive for individual and institutional excellence, self-improvement and education.

The techno-catalytic potential of outer space exploration and utilization has already been proven to a large extent. Space exploration with its multiple facets can probably encompass and produce most, perhaps all of the catalytic effects and benefits noted above. As was demonstrated in the initial phase of the space program, the exploration of outer space can significantly accelerate the creation of new, economically beneficial and transferable technologies (ref. 2 presents a few examples of space technology transposition). The importance of this capability and how it should be used in the future, not just in terms of the United States, but in terms of the entire world, will be discussed in the following sections.

A rationale for proceeding with the settlement of the inner solar system--the Moon, Mars, the vicinities of the Moon and Mars etc.--becomes fairly apparent from examining past commercial achievements in space over the last 30 years. Further justification may also come from the recent realization that many of today's terrestrial energy related and manufacturing and production technologies are having a serious and perhaps irreversible impact on the Earth's ecological system. As the next century dawns, this situation must be brought under control before it becomes critical.

Unexpected and Unparalleled Growth and Contributions

Since the inauguration of NASA and the space age in the 1950's and '60's, there has been a definite increase in the rate of technological innovation that can be directly attributed to those space related activities--most of which fall under the category of exploration or exploitation, both manned and unmanned (ref. 3 briefly discusses some past accomplishments and the ingredients for success, and predicts the future commercialization of space). Many economically viable products/derivatives became available, but were never imagined before the space program began. Solar power and satellite technologies are two of the most prominent products that have produced a significant return on the investment in space by revealing enormous, attractive markets with growing economies of scale. Power from the Sun emerged as one of the most viable alternatives to the fossil fuel (petroleum) energy shortage of the 1970's. Combined with nuclear systems, solar power might become virtually indispensable in the 21st century as the world's economical petroleum reserves are exhausted (based on present energy production and consumption rates; and, on how much this planet's ecosystem can bear before becoming critically unbalanced). NASA's solar energy conversion technology has been accepted by the commercial sector emerging in wrist watches, on top of houses, and as commercial (to some extent) power systems in some foreign countries. Methods derived from NASA's communications technology have revolutionized the world-wide communications industry. The commercialization of this technology has also allowed deep penetration into consumer markets creating new growth and vitality in the commercial sector. Evidence of this can clearly be seen from its emergence as satellite receivers in the backyards of homes and businesses around the world.

Many available products and services, now taken for granted, originated from the initial space activities of the mid-20th century. Several diverse areas have benefitted from NASA's space technology over the course of the past 25 years. Some examples are (ref. 4): health and medicine, public safety, consumer/home/recreation, environment and resources management, food and agriculture, manufacturing technology and industrial productivity, energy, construction, transportation, etc. The stringent restrictions on mass and volume naturally imposed by launch requirements were most instrumental in bringing about microelectronics and the miniaturization of the computer. This system has had one of the most amazing impacts on society. It revolutionized medical technology and manufacturing and production techniques, and has enabled more fundamental scientific principles to be explored and applied. The micro/mini computer, as a most prodigious result of early space activities, is now synonymous with the contemporary interpretation of modernity.

With regards to the subject of this paper, it should be understood that the successful utilization of any technology catalyst depends on an ability to harmoniously complement or interact with all significant aspects of any contemporary socio-political needs agenda. It is in this especially subtle sense that the exploration of space triumphs. The space exploration catalyst possesses the following suitable characteristics:

- (1) Consists of an infinite source of random challenges or stimuli.
 - (2) Marketability and natural acceptability in today's social and political climate.
 - (3) Adjustable costs and cost effectiveness relative to society's potential financial resources (ref. 5 refers to a 1970 Econometric Study which proved a 5 or 7:1 payback ratio on space investments).
 - (4) Contains a large potential for industrial development/economic exploitation that could return profits on the initial investment.
 - (5) Engenders a deep sense of destiny.
- (A most unattractive characteristic is the large initial financial and capital investment required from a profit standpoint, and the unpredictability of the scope and vitality of the commercial prospects in its evolution--refs. 6 and 7.)

Space-age technology is, has been, and can continue to be the largest and most conspicuous contributor to economic growth in the modern, industrialized world, now and in the 21st century (ref. 8). The results of the initial phases of the space age have permeated, invigorated and spurred innovation in practically every facet of contemporary existence with a very large, net positive, economic impact. There is every indication that space technology transfer will continue generating economic windfalls for society, and that a further investment in the catalytic effects of space related activities can precipitate many more unforeseen benefits.

To Preserve the "Global Showcase"

Along with the required socio-cultural needs for commercial/economic development, the 21st century portends a complex variety of rather ominous, more or less scientifically verified natural challenges which would also need to be addressed before they arrive. But, the large array of new technologies which will most certainly be required (within the next 50 years perhaps) may be evolving too slowly. Some examples of these looming, future terrestrial challenges are:

(1) Short-sightedness and irresponsible attitudes on the part of most industrialists towards the environment.

(2) The rapid exhaustion of economically accessible petroleum fuels (not readily substitutable).

(3) Global warming/"greenhouse" effect causing rising sea levels which will engulf many low lying coastal land areas.

(4) Desertification and drought in Northern Africa and other regions of the world.

(5) Water table depletion and chemical contamination in many North American farm regions.

(6) Significant increases in global human populations and a decreasing food supply potential.

(7) Critical overcrowding of many major cities throughout the world.

(8) Air pollution and acid rain causing the sterilization of rivers, lakes, ponds, and forests in Europe and North America.

(9) Depletion of the ozone layer allowing increasing levels of ultraviolet radiation to impinge on the Earth's surface.

(10) Deforestation of tropical rain forest critical to the Earth's ecological balance, etc.

These are just a few of the problems for which 21st century civilizations (and beyond) will have to find solutions (Tofler, "Future Shock," 1970, discusses the significance of "technology backlash" which seems pertinent to the present subject matter). To reduce or offset the impact of these impending dangers, human beings should begin to appreciate the possibility that space exploration and exploitation activities might not only offer social and material benefits, but might also offer the largest potential source of achieving technological and ecological harmony on Earth.

That humankind will continue to evolve technology, and use it to assert its dominance over nature on Earth and on certain aspects of itself, is quite difficult to deny (ref. 9 mentions the possibility that, "the space program likely will sharpen awareness of the fundamental unity of nature and of humans as a natural development of the same natural forces responsible for cosmic activity"). Those foreboding trends mentioned in the list above will most certainly continue, and there are no strong indications that we presently feel

(uniformly) compelled to reduce our dependence on many productively employed but environmentally harmful technologies. Presumably, then, the spectrum of 21st century wants and needs might continue to be satisfied by many inappropriate methods. In the face of this dilemma the almost imperceptible deterioration and undermining of the Earth's ecosystem continues to grow.

Whether driven by basic economic, military, or commercial needs, technology will always be incongruous with nature. However, the best possible effort should be made to minimize the decadent impact on the ecosystem. The exploration of outer space, with its natural emphasis on the safe utilization of pure technology (the purest imaginable), can be used as a catalyst to accelerate an urgently needed revolution of new technologies. The knowledge needed to promote the entrance of the most efficient technological processes permitted in nature must be vigorously sought, harnessed, and brought into service (Tofler, "Future Shock," also discusses the role of new knowledge in society). Acquisition of such knowledge should be accomplished during the "past" of those future generations who will soon inherit the Earth (we cannot afford to wait for the Earth's environment to provide the impetus--by that time, it may be too late). In all simplicity, if it is assumed that the level of efficiency or sophistication at which new technologies enter into being is directly related to the challenges they must address, then, the greater those challenges can be made, the greater and more sophisticated will be the ensuing technologies. Undoubtedly, space can provide such a challenge, and it can be used now.

In the 21st century, the ecosystem, with its complex array of natural laws and subtle balances, will inevitably force human society to impose tighter and ever more stringent controls over the production of energy and introduction and utilization of contaminating goods and services. NASA (in its present form) appreciates and understands the uniqueness of this fragile system--the only known planet to have permitted life, human life, and consequential technology, to emerge, flourish, and evolve by providing all the necessary random biological, societal, scientific, and material sequences and alignments. NASA also understands that the post-20th century mix of societal and technological constituents may have to be altered in order to preserve and not overwhelm and eventually poison the Earth. As the next century approaches, therefore, many of the existing 20th century terrestrial relationships between mankind, his technology (commercial and otherwise), and the environment, may have to be rapidly modified or completely abandoned.

NASA suggests that a serious investment in certain space exploration and exploitation activities, with particular emphasis on sustained human assisted operations within the inner solar system (the Moon, the planet Mars--Phobos, Deimos, etc.), can probably provide the most vibrant, "broad-based" technology stimulus to precipitate the emergence of a wide variety of ultra-modern technologies. Most importantly, though, the agency believes that these future systems could greatly assist in transforming our terrestrial infrastructure. After being forged by the full force of this powerful technology driver, future terrestrial applications should possess the characteristics best capable of blending with the natural systems and conditions expected to exist on 21st century Earth.

The Ultimate Pull

Interest in the exploration of outer space, to date, has been driven by three primary factors: (1) curiosity about the other planets in the solar system, and the omnipresent universe; (2) the probable existence of alien/extraterrestrial life; and (3) the commercial (and military) need to more rapidly interact with other human communities, constructively or destructively, within the presently limited confines of this planet. It is the third factor that contains the essence of a possible guarantee for the utility of outer space as a technology catalyst.

The trace of human history seems to show that the dispersion of human communities around the Earth (along with the need for energy, food and shelter) has been one of the most significant impetuses behind the creation of those seemingly basic technologies that effectively compress time and space. Most other technological developments (power, medical, military, etc.) appear secondary, and seem to revolve around that fundamental need to rapidly reach and communicate. Communications and transportation systems, and the other secondary technological effects, would probably never have emerged if sizable human separations had not been part of the human reality. Consequently, all of the relatively rapid modes of transportation and communications (from the modern perspective; cars, trains, aircraft, ships, satellites, telephones, radio, television, etc.) probably would not have evolved. In so far as this is concerned, the Earth no longer seems capable of providing a worthy challenge to this ultimate technology puller, human physical separation. To further use this phenomenon, extraordinary, remote human settlements should be placed on the surface of other distant planets. In so doing, new deficiencies would be created and accentuated. The intense human response to such a challenge is quite predictable (this would clearly be considered a natural response to an external stimuli, one of the fundamental laws governing animal interaction with nature). Although the resulting advancements of technology cannot be accurately forecasted, it is almost certain that time and space will be further compressed--the degree to which this will occur is anybody's guess.

The Purpose in Beings

Whether mankind can ever permanently inhabit outer space, in the truest sense, is a most profound question. Nowhere on the warm embracing Earth along the stretch of a thousand millenniums have we ever encountered such a dreadfully unfriendly and unforgiving place. Nestled within this solitary entrance, noticing, questioning the vast mysteries of being, consciousness and awareness, matter, space and time; the universe progresses in a dynamic interplay (Capra, "The Tao of Physics," 1982, discusses many striking similarities among the western/mathematical and various eastern/mystical interpretations of a dynamic universe). Somehow, within it, we exist. There, attempting to understand, attempting to experience scientifically, technologically, and physically, perhaps, we perpetuate reality and purpose, and continually alter philosophical constructs. Maybe, survival beckons.

In the coming millennium, the sublime reality of outer space offers an enduring challenge and quiet promise: continuous uncertainty prosecuted by a relentless unknown; a ceaseless pursuit, a never ending quest. Humanity: immutable energy of potentially universal cognizance trapped within a mutable

biological shroud of limited range; a solemn and singular response. Endowed with adaptability and creativity; a slow liberator. The complementary technological consequence it follows; a desolate, singular path. Natural growth, perhaps, or a natural destiny that might ultimately expand the boundaries of life and thought into the boundless realms of outer space. Pursuing, stretching for the boundaries of the Moon and Mars, humanity can awake one future day to find the promise of terrestrial survival more assured, and the relentless journey progressing in a more comprehensible way. As the new millennium unfolds, the universal benefits should grow more and more pronounced. A most unique and complex planet, the Earth will be greatly enhanced, balanced and preserved; ecologically, economically, sociologically, politically, and philosophically. And then, perhaps, from an acute retrospective of the distant future, everlasting reverence for the tremendous fortitude seen through the vestiges of noble ancestral relics--life, a delicate continuum, transcending time and space.

Space, an infinite source of challenges, is, by definition, unconquerable. It is the most fertile technology catalyst that a technological civilization can ever hope to utilize. A reservoir of innumerable and unknown effects and phenomena, it can eternally enrapture and stimulate the creative imaginations of all thinking beings.

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